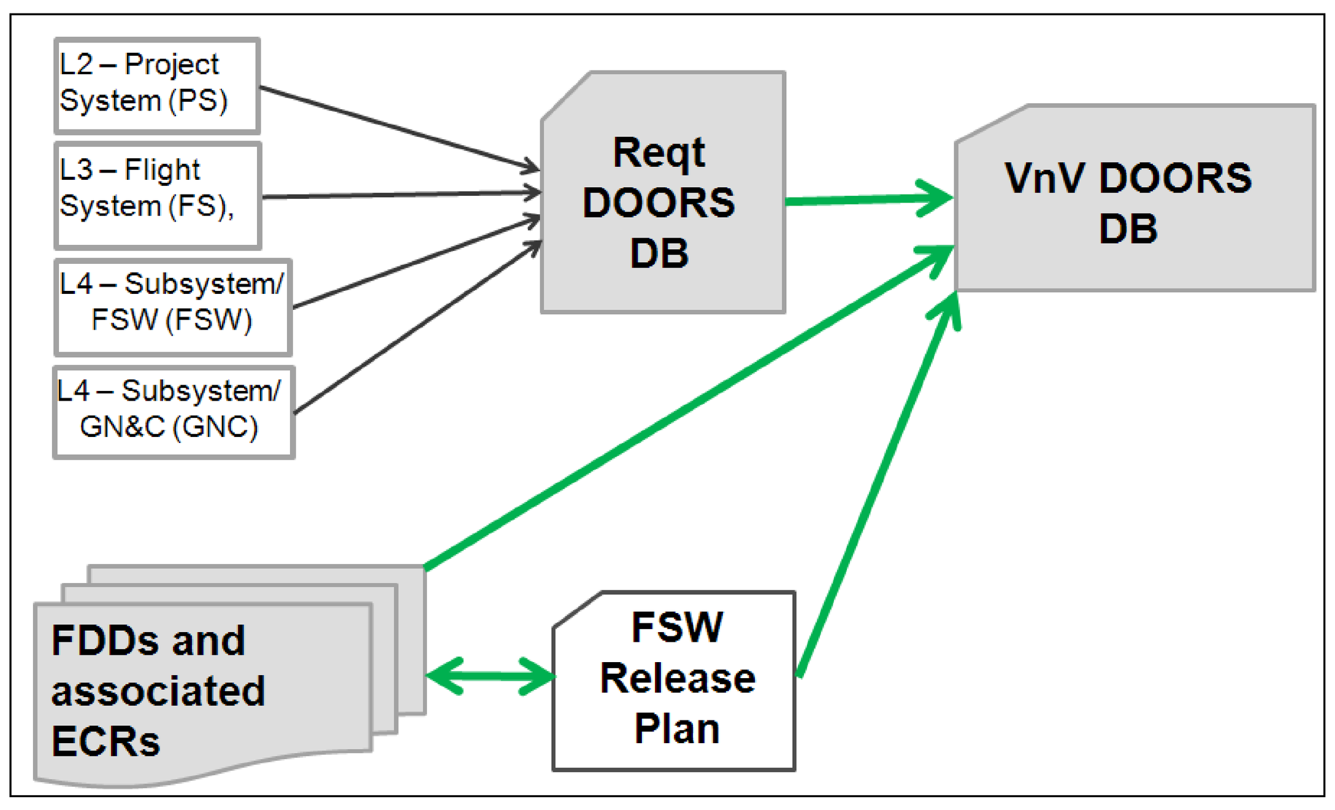
Developing Tools for IV&V Software Regression Analysis, Change Impact and Issue Resolution

Introduction:

The IV&V Test Analysis team faced the situation where a Project was using a non-traditional tracking and non-integrated system for requirement creation, implementation and verification. Essentially, there were four repositories for requirements. The concern that this raised was that as a requirement proceeded through the software development cycle, the requirement may not stay consistent and possibly even get "lost." In performing test analysis, we wanted to ensure that all of the correct requirements would get tested.



Project Requirements Flow

Problem Definition:

The various project tracking sources (see Requirements Flow figure above):

•The Project is using Functional Design Descriptions and Requirements Documents to define the requirements.

•The Level 1,2,3 & 4 requirements are being collected and stored in the Requirement DOORS Database.

•The FSW requirements are being collected in the FSW Release Plan.

•All requirements should be collected in the VnV DOORS Database for verification tracking.

These resulted in two different source sets of documents, two separate intermediate collection sources and one all encompassing validation and verification database. These various requirement sources are collected in Word documents, Excel spreadsheets and DOORS databases.

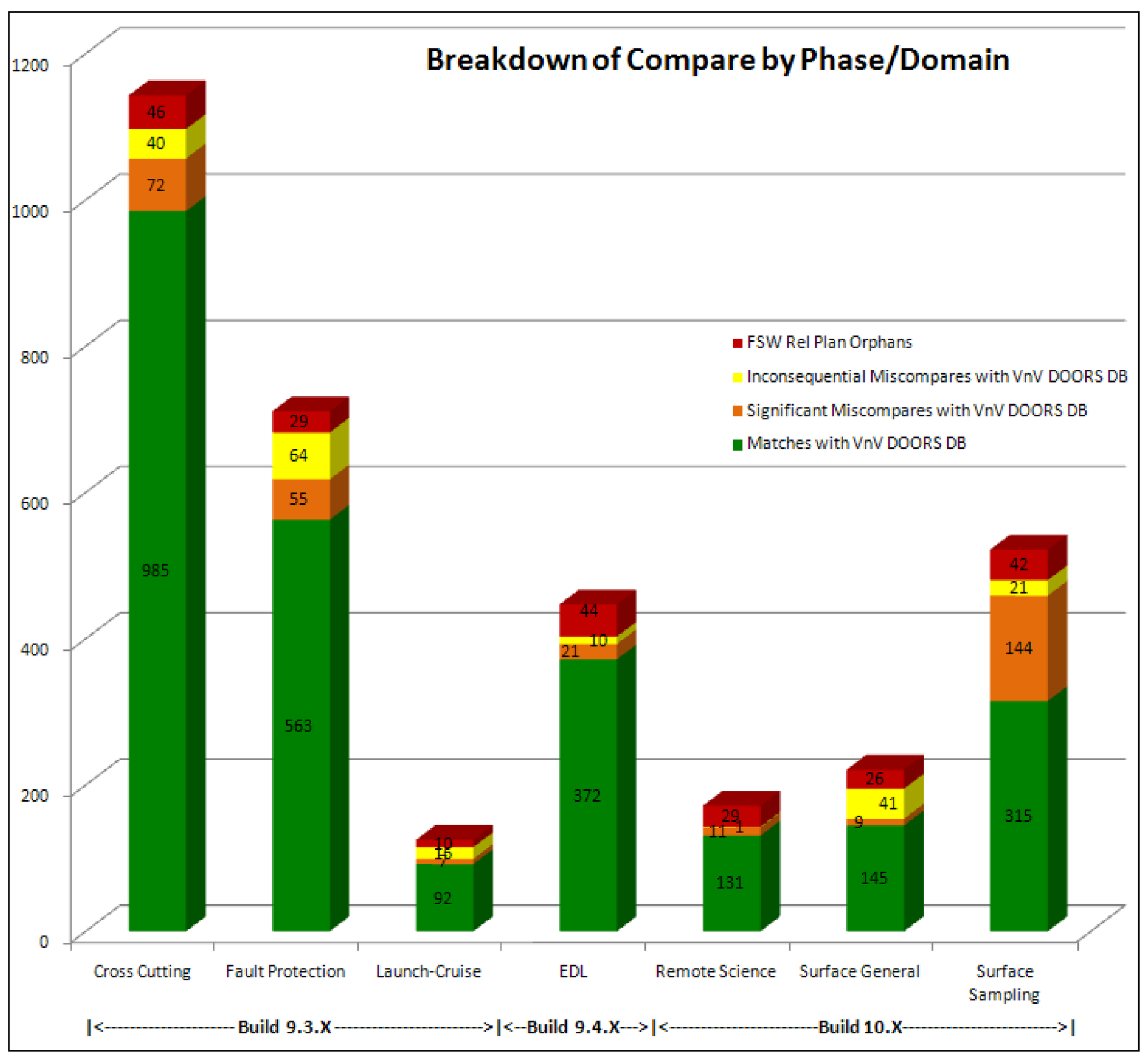
The difficulty that we faced was getting all the requirement sources in one consolidated source in order to perform analysis.

Solving the Problem:

1. We needed to determine what product we were going to use to perform the comparison analysis. Some choices that were considered were MSExcel, MSAccess, SQL or DOORs. When the effort was started, the scope didn't seem as large as it has ended up being, this led us to use Excel as it is the easiest to start up and the simplest to use. The tool was augmented with Visual Basic to perform necessary computations.
2. All of the requirements needed to be exported from the tracking source that they existed in and needed to be imported into the Excel spreadsheet. We needed to manually pull the requirements from the Word documents, pull the worksheet of requirements from the FSW Release Plan and then learn DOORS and how the project was using it in order to export the requirements out of the DOORS databases.
3. Once we had all the requirements imported into Excel, we had to determine the status of all the requirements. By understanding how the requirements were designed to move from source to source, we could then check to determine if the requirements correctly flowed from one source to another (i.e. if they got "lost"), if they flowed completely from one source to another (i.e. if the requirements stayed consistent) and if there was a trace acknowledging that a requirement was deleted.
4. The spreadsheet resulted in multiple tabs that included:
   - Four tabs for the four requirement tracking sources.
   - Five tabs for all the individual comparisons (green arrows in the Requirements Flow figure above)
   - One tab for a composite look at the overall comparison
   - Four tabs for a metrics summary of the comparisons

Reqt ID	Requirement Text (from FSW Release Plan)	Requirement Text (from FDDs/ECRs)	Requirement Text (from Reqt DOORS DB)	Requirement Text (from VnV DOORS DB)	Phase/ Domain	FDD	Needs Update per Cichy	ECR Trail Issues	Issue in Regression Analysis
FSW-SMC-32	FSW shall implement the default tables listed in the Appendix of D-34206, the S/C Modes and Configuration FDD, "Default Tables" Rev.6.	FSW shall implement the default tables listed in the Appendix of D-34206, the S/C Modes and Configuration FDD, "Default Tables" Rev.6.		Not In DOORS Test DB	Cross Cutting	Spacecraft Modes and Configuration			Orphan
FSW-104	The FSW shall deliver a Descent Stage Pyro Event command requested during the current 64 Hz cycle to the MCIC Bus Controller for transfer to the targeted DREU(s) on the next available 64 Hz cycle.	The FSW shall deliver a Descent Stage Pyro Event command requested during the current 64 Hz cycle to the MCIC Bus Controller for transfer to the targeted DREU(s) on the next available 64 Hz cycle.	The FSW shall deliver a Descent Stage Pyro Event command requested during the current 64 Hz cycle to the MCIC Bus Controller for transfer to the targeted DREU(s) on the next available 64 Hz cycle.	The FSW shall deliver a Descent Stage Pyro Event command requested during the current 64 Hz cycle to the MCIC Bus Controller for transfer to the targeted DREU(s) on the next available 64 Hz cycle.	Cross Cutting	Pyrotechnics			
FSW-105	The FSW shall deliver a Rover Stage Pyro Event command requested during the current 64 Hz cycle to the MTIF Bus Controller for transfer to the targeted RREU(s) on the next available 64 Hz cycle.	The FSW shall deliver a Rover Stage Pyro Event command requested during the current 8 Hz cycle to the MTIF Bus Controller for transfer to the targeted RREU(s) on the next available 8 Hz cycle.	The FSW shall deliver a Rover Stage Pyro Event command requested during the current 8 Hz cycle to the MTIF Bus Controller for transfer to the targeted RREU(s) on the next available 8 Hz cycle.	The FSW shall deliver a Rover Stage Pyro Event command requested during the current 64 Hz cycle to the MTIF Bus Controller for transfer to the targeted RREU(s) on the next available 64 Hz cycle.	Cross Cutting	Pyrotechnics			Miscompare
FSW-106	The FSW shall construct the EDL 1553 Bus List such that the transactions associated with a Descent Stage Pyro Event are the first or second set of transactions following the control cycle start transaction.	The FSW shall construct the EDL 1553 Bus List such that the transactions associated with a Descent Stage Pyro Event are the first or second set of transactions following the control cycle start transaction.	The FSW shall construct the EDL 1553 Bus List such that the transactions associated with a Descent Stage Pyro Event are the first or second set of transactions following the control cycle start transaction.	The FSW shall construct the EDL 1553 Bus List such that the transactions associated with a Descent Stage Pyro Event are the first or second set of transactions following the control cycle start transaction.	Cross Cutting	Pyrotechnics			
FSW-107	The FSW shall construct the Rover 1553 Bus List such that the transactions associated with a Rover Stage Pyro Event are the first set of transactions following the control cycle start transaction.	The FSW shall construct the Rover 1553 Bus List such that the transactions associated with a Rover Stage Pyro Event are the first set of transactions following the control cycle start transaction.	The FSW shall construct the Rover 1553 Bus List such that the transactions associated with a Rover Stage Pyro Event are the first set of transactions following the control cycle start transaction.	Not In DOORS Test DB	Cross Cutting	Pyrotechnics	X		Orphan
FS-PYRO-02	Deleted in R9.2	The FS EDL behavior shall wait for 3 seconds after applying logic power to a pyro card before applying pyro bus to that pyro card		Not In DOORS Test DB	Cross Cutting	Pyrotechnics			

Overall Comparison Analysis Results



Comparison Metrics Summary Results

Difficulties Overcome:

•The biggest issue that we faced in the comparisons was that due to all of the varying sources of requirements, the formatting of the requirement IDs and texts from one source to the next was quite different. Spaces, returns, special characters, etc… created difficulty when trying to match IDs and then comparing the requirement text. Using combinations of various Excel functions such as Substitution, Index, Match, etc… we were able to overcome the formatting issues.

•Once the comparisons were completed, all of the discrepancies would be categorized correctly. The problem category was the one where the requirement texts did not match. The difference between the mismatches that are valid (the mismatch is because of requirement text differences that create different meanings) and the ones that are inconsequential (the mismatch is due to slightly different requirement texts that do not have different meanings) are difficult to automatically determine. This requires an analyst to manually determine the difference.

Results and Ideas for the Future:

•This analysis has been well received by the project and has resulted in considerable findings that have prompted the project to perform work in reconciling the differences found. The project systems engineer uses these comparisons as a wedge within the project to achieve a single set of requirements. The analysis has been adopted as a necessary function moving toward Readiness Reviews and is performed on a monthly basis.

•In tracking the flow of the requirements, the tool has proven to be valuable in performing change impact and tracking issue resolutions. As IV&V performs analysis at each level of FSW, requirements development, implementation and verification, we need to ensure that the requirements that are being used for each phase are consistent. This analysis that we perform allows us to flag requirements that may need revisited or it may allow us to clear existing issues where the wrong requirement was evaluated.

• If this tool were to be developed again or needed to be adapted to a different project, the SQL option for the application would be a better option. The expandability of SQL would allow for a more diverse tool.

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